13 New and Emerging Technologies

13.1 New and emerging technologies

emerging technology: New or existing technologies that are still in development to allow them to reach their full potential.

Near Field Communication (NFC)

- NFC is a communication protocol that allows two devices to connect to each other wirelessly and share data
- Although it is similar to Bluetooth it doesn't require a pairing code or password .
- Bluetooth average proximity is 100m whereas NFC must be used within max 20 cm range
- Connecting through an NFC than Bluetooth is much quicker.
- NFC are a modern technology that are present in most smartphones and smart watches

Uses:

- **Passive NFC Chips:** The use of those is similar to QR codes, they can be built into buildings, bulletin boards, etc in order to distribute data. User just needs to point their NFC enabled device towards the information point and data is received almost instantly without the need of scanning it like QR codes.
- **Electronic Wallets:** NFC are used to enable contactless payment via mobile phones/smart watches and credit cards. Credit card have a built in NFC chip.
- **Smart ticketing:** transit passes details can be stored in an nfc chip, hence allows user to travel without them
- **Sharing photos**
- **Unlocking doors:** employee pass / house key can be stored on phones now to unlock doors

Difference between Bluetooth and NFC:

- Max working range of NFC is max 20 cm whereas Bluetooth is 100 m so users have to be very close.
- Data exchange is slower using an NFC than Bluetooth so takes longer to transfer files.
- NFC uses much less power than Bluetooth
- NFC connections re automatic whereas Bluetooth requires pairing code
- NFC connections are peer-to-peer whereas Bluetooth allows upto 7 devices to be connected simultaneously
- NFC is a new emerging technology hence fewer devices only support it / older devices can't make use of it whereas Bluetooth is standardized now.
- NFC connects instantly with another device whereas Bluetooth takes longer

Advantages:

- Wireless communication so no cabled connection is required
- Fast method of data transfer
- Present in many modern mobile devices so is becoming more universal.
- Does not require an internet connection.
- Does not require a pairing code.

Disadvantages:

- Can be seen as less secure as user doesn't need to authenticate the pairing of devices.
- Users are concerned that the technology could be used to steal their data.

Ultra-High Definition Television Systems

- The quality of the image produced on screen depends on the resolution of the screen which is the number of pixels that can be displayed on screen. The higher resolution means a clearer image
- Standard HD used to be the highest quality that a picture could be displayed in.
- However 4k and 8k screens have been developed that produce ultra-high definition (UHD)
- UHD has resolution of 4 times the number of pixels as HD
- UHD have increased dynamic range and color depth compared to HD

- More LEDs in a given are on screen increase the resolution so there's more details
- 4k televisions are commercially available and more common place now however 8k screens are very limited and only used in commercial applications such as cinema screens.
- UHD requires high speed internet connection and a method to broadcast 4 times much data than for an HD.

Uses:

- **surgery:** Medical grade computer have been introduced which have 4k screens, they are used in surgery to view the surgery in process. The 4k resolution allows to have a higher level of visibility of the surgery and enables a greater level of precision when carrying out surgical tasks. It also allows surgery to be carried out remotely using a very high quality image.
- **cinemas:** 8k screens are no being used in cinemas for greater visually entertaining experience and to allow a greater level of immersion.

Advantages:

- Quality of the image is sharper and clearer.
- Can produce a higher level of detail in an image.
- Can improve the viewing experience for the user.

Disadvantages:

- The technology required for UHD screens is more expensive to manufacture.
- It requires a large amount of data to be transmitted by television broadcasters to achieve a UHD image.
- An internet connection at least 25mbps is normally required to stream content at a UHD level.

Artificial Intelligence

- AI allows computers to make decisions and respond to situations like humans. It involves programming computers to think and learn.
- AI systems follow set rules and can adapt based on their experiences, appearing to think but actually responding to programmed instructions

- It relies on knowledge engineering to access a knowledge base and be able to establish relationships
- Machine learning is also an important part as it allows AI machines to recognize patterns from input and enhance its ability to analyze and learn

Uses:

- **self-driving cars:** These are cars that are able to automatically change lanes, maintain speed and slowdown if they sense they are approaching another car. Self-driving car aim to improved life for commuters by eliminating the need for human drivers, reducing accidents caused by fatigue and emotional reactions
- **scientific analysis:** Scientific research organization record a large amount of data daily, the use of AI enables analyze the data much more quickly and with a greater level of accuracy. AI s used to identify patterns and trends in data that can be used to form hypothesis or future scientific discoveries. This outweighs the capabilities of a human in this application.

Advantages:

- Increased level of precision and accuracy as will likely have a lower error than a human
- Can replace the need for humans in tedious, repetitive or dangerous tasks
- Machines do not require rest, so can be used 24/7
- Can make logical decisions, void of emotion, so can provide a rational outcome.
- Can analyze large sets of data in a much more efficient fashion than a human.

Disadvantages:

- Requires a high level of skills to program so can be very expensive to create
- The storage requirement of the program and knowledge base can be very extensive, creating greater expenses.
- People have ethical and moral issues with computers being used to recreate intelligence.
- They don't consider emotion when making decisions, so this is not considered. This also means they are not fully capable of human emotions such as empathy and sympathy
- As they are fundamentally based on rules, this can affect their ability to be creative.

Augmented Reality

- AR is a technology that overlay s computer generated images onto a user's view of the real world through devices like smartphones, AR glasses or tables.
- It enhances the user's perception by blending the physical and digital realms offering interactive and immersive experiences.
- It works by using devices like cameras and sensors to sense the real world, then processes the data gathered by them to recognize objects and understand the users environment
- Users can interact with augmented content through gestures, taps or voice commands
- AR continuously adjusts the overlay in real-time to stay aligned with changes in the surrounding environment.

Uses:

- **Gaming:** creates a more immersive gaming experience by blending virtual gaming characters onto real world and using physical commands like voice to control the characters.
- **Navigation:** Provides real time directions and information by overlaying arrows or information onto the users view such as street name, helping them navigate through he real world
- **Education:** Can bring textbooks to life with 3D models or provide virtual tours of historical sites
- **Healthcare:** Surgeons can use AR overlays to view critical information during procedures

Advantages:

- Can make a learning experience both entertaining and more immersive.
- Can be used to simulate and communicate immediate information, creating a better experience when used in a learning and training capacity,
- Can allow a user to simulate everyday experiences in an efficient manner. It can allow shopper to simulate trying out different clothing and hairstyles, without actually changing their clothing or hairstyles.

- Can be used to allow a user to navigate a new place, helping them to easily find the services and attractions they require.

Disadvantages:

- It is based on the collection and analysis of data. This has caused some people to be concerned about the privacy and security of the data
- Some people believe that it can modify a person's perception of reality and can cause a blurred distinction between the two.
- The technology required to process the data needed for a smooth AR experience needs to be fairly powerful, This type of technology is expensive to manufacture.

Virtual Reality

- VR refers to a computer generated simulation that immerses users in a digital 3D space that doesn't exist in their real world
- The user makes use of specialized hardware like headset and motion controller in order to interact with the vr world
- The vr headset uses two camera feeds for left and right eyes in order to mimic human vision
- The user also requires handsets or gloves to monitor users hand, the use of these devices allow the user to move around and interact in a virtual room.

Uses:

- **gaming:** Immersive gaming experience that makes players fell like they are inside the game
- **education:** Virtual field trips, simulations and immersive learning environments
- **healthcare:** Medical training, therapy and rehabilitation programs.
- **tourism:** Virtual travel experiences and 360 destination previews, walkthroughs of places

Advantages:

- Can be used to simulate critical situations for organizations such as hospitals and the military, to provide a training tool to develop the necessary skills required for dealing with the crisis.
- Can be used to provide a very immersive experience into a different reality than the immediate real world. This can enhance the gaming experience. It can also provide a relaxing or calming environment, to help people with stress or mental health issues.
- Can help build a person's confidence if they can replicate a situation that allows them to practice for a certain scenario

Disadvantages:

- Achieving perfect calibration between the cameras and the user can be very difficult. If it is not accurate enough, it can cause the user to get a feeling of motion sickness.
- The technology required to create the VR experience is often expensive to manufacture.
- Some people think that there is a danger that people can be seduced by an alternate reality and neglect their real world reality as a result.

Robotics

- A robot is any machine that can perform tasks that would otherwise be performed by a human.
- They can be programmed to do this automatically or through the direct instruction a human.
- They normally make use of microprocessors and sensors
- Sensors sample data from surrounding and send it to microprocessors which analyses it against stored data and sends signals back to the robot accordingly on what action to take

Uses:

- **robotic prosthetic limb:** A robotic prosthetic can be connected to a human mind to train their brain to be able to move the robotics in the prosthetic, creating a working limb
- **surgical robots:** Assist surgeons in performing precise and minimal invasive surgeries

Advantages:

- Can perform task that might be tedious or dangerous for a human
- Do not require a break, so can work 24/7 if necessary
- Can improve a person's quality of life
- Not prone to error like a human can be
- Can help reduce time and costs in manufacturing as can often complete tasks quicker and more consistently than a human is able to.
- Robotic pets can be used to increase the quality of life for those who are not able to have real life pets, due to issues such as allergies. Robotics pet have also been used to help people with depression.

Disadvantages:

- Can be used to replace humans in certain jobs and may take much needed jobs from some humans.
- Can be paired with artificial intelligence and therefore learn, but are not capable of an emotional response.
- Require a constant supply of power. This can be expensive and can have a lasting impact on the environment.
- Designing and building robots requires a high level of skill and high quality materials to make sure they are reliable. This can be very expensive.
- Some humans fear the use of robots and don't agree with our current dependence on them.

Computer-Assisted Translation

- Computer- assisted translation is the use of software to support human translators.
- It includes features like storing past translations for reuse and managing consistent technology.
- While it automates some tasks it still relies on human expertise for context and quality.
- It works by taking a document, recognizing its elements and translating them into a chosen language
- Unlike human translators, its tools rely on a database to match words and apply grammatical rules of a language to construct a translation.

Uses:

- **translating foreign language websites:** Makes resources and services online more accessible
- **spell checking:** Can be used as a spell checker tool, it uses it database to compare the spellings of the words used in documents against the spellings stored, allowing any incorrect words to be corrected
- **live subtitles:** Can be used to translate audio into visual text, regardless of the language being used, can also translate an audio in one language to its transcript in another language.

Advantages:

- People can get access to an instant translation of a document from one language to another. This can save time and improve communication.
- It can help reduce errors that may be present in manual translation methods.
- Translation tools are quite widely available and are therefore a relatively inexpensive tool.

Disadvantages:

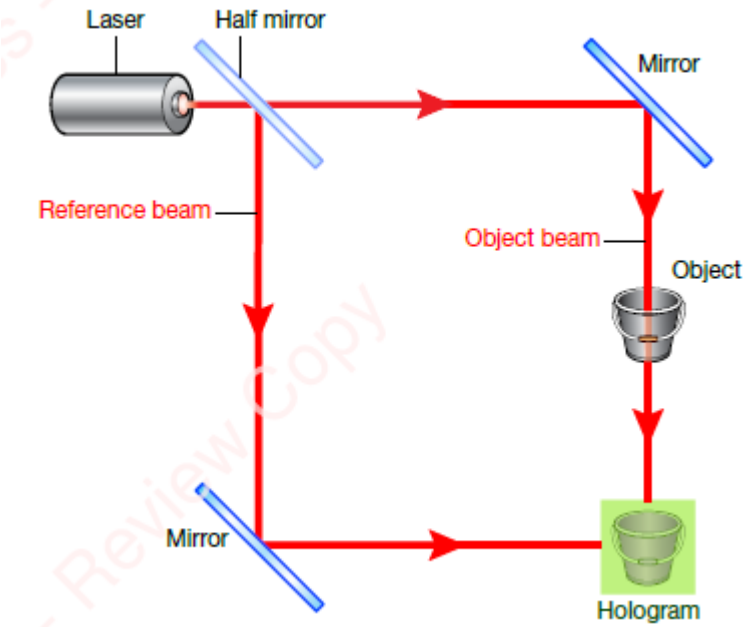
- Some people are skeptical about the accuracy of the translation that computer assisted translators are capable of.
- Some people find that certain terms in a language are used in a context, for example a slang or colloquial language, Translation tools can often struggle to interpret these terms if used within a certain context.

Holographic Imaging

- Holographic imaging is also known as hologram.
- A hologram is 3D image that is created using laser beams (reference beam and object) and mirrors to make it look real and have depth.
- The laser beam is split up by reflecting it off mirrors and when they recombine, they create the holographic image.
- A hologram can be a 2d image that appears to be 3d as it moved or it can be an image that is actually 3D and free standing

How do holographic imaging works: (4 marks)

- It makes use of laser light to form interference patterns
- It uses object beam and reference beam with one wavelength
- Object beam is passed through scene onto a recording medium
- Reference beam only hits recording medium
- Object and reference beams create an interference pattern and create image on a recording medium placed where the beams hit
- Medium and beam must not move
- Reference beam is used to recreate hologram from pattern on plate by diffraction



Uses:

- **security:** Holographic imaging is used in security to create hard to copy holograms on items like currency, cards, passports and product packaging. These holograms sere as anti-counterfeiting measures verifying authenticity and deterring fraud
- **art and entertainment:** Used for artistic expression and in holographic displays for immersive entertainment experiences.
- **medical imaging:** Used for detailed visualization of organs and tissues in medical diagnostics, providing a more comprehensive view than traditional imaging methods.
- **architecture:** Provides a realistic 3D view of a planned building, offering more clarity than traditional 3D models, This helps architect convey their designs more effectively to construction companies, saving time in understanding the plans.

Advantages:

- They do not require special glasses to view 3D effect.
- They are very difficult to replicate so can be useful as a security measure.
- If it much easier to see depth perception on a 3D projected hologram, than in ordinary 3D images.

Disadvantages:

- 3D projected holograms require expensive equipment to create.
- A lot of data needs to be stored in order to create holograms an d the cost of data storage can often be expensive.

Holographic and 4th Generation Optical Data Storage

- Green and red lasers are used to record data as holograms
- Light from both is sent in parallel stream
- There is minimal divergence
- Green laser reads the data from top layer of disc
- The data is stored as holographic laser interference patterns
- Red laser reads reference data stored on aluminum layer at bottom of disc layers
- A mirror allows red laser to pass while reflecting green layer
- This method enables to store 100 GB to 1 TB of data on a single storage crystal which is about the size of a grain of sugar.

Uses:

- **Taking data in space:** It is ideal for sending large data amounts into space. Its high capacity and compact size make it suitable for space missions where data transmission is limited and cargo space is precious.
- **Archiving and backup:** Ideal for long term data archiving due to its high capacity and durability. It's useful in businesses, libraries and government institutions for storing historical records and backups.

Advantages:

- Large amounts of data can be stored on a very small medium
- It will make the storage of large amounts of data much more portable
- It is capable of storage of millions of bits of data at a time, making transfer rates much faster than current methods.

Disadvantages:

- It is not compatible with current methods of data storage. This would make reading the data very difficult.
- The technology required to use holographic data storage is currently very complex and expensive.

3D Printing

- 3D printing is also known as additive manufacturing, is a process of creating three-dimensional objects by layering material based on a digital model.
- A 3d software based model is created using computer aided design (CAD) software.
- The data to create this model is transmitted to a 3D printer.
- The 3d printer then creates the model by layering very thin materials such as plastic.

Uses:

- **bespoke prosthetics:** 3D printing is used as a method of bio-printing. This practices like tissue engineering to be developed. The layer by layer method used in 3D printing is used in tissue engineering, layering biomaterials to create tissue-like structures. This technique can also be used to print organs and artificial blood vessels that can used to aid drug and other medical research
- **printing in space:** As storage is limited in space, limited amount of items can be taken there like repair parts and other necessities for space station in every mission. Hence a 3d printer can be used to copy and repair the space station much quicker.

Advantages:

- The speed at which certain objects can be created is greatly increased through the use of 3d printing,
- A 3d printer will consistently create the exact same product from a model. The level of consistency would be much greater than when created by a human.
- Much more flexible when creating complex models, especially those that have hollow cavities within solid parts.
- Although the initial setup costs will be high, the cost of creating each product with a 3d printer will often be much cheaper than alternative manufacturing methods.

Disadvantages:

- It has become much easier to build dangerous and counterfeit items, which causes greater security and fraud issues.
- At present, 3d printers are only capable of creating relatively small items, Developments are progressing to increase the size of the objects that a 3d printer is capable of creating.
- 3dpriting reduces the number of manufacturing jobs, as it is able to replace the need for humans to create the products.
- 3d printing requires a relatively higher level of power consumption. This can be harmful to the environment as it increases emissions.
- At present, ABS filament is the most common type of material used in 3d printing, The by-product of this plastic is increasingly dumped in landfill and negatively affects the environment.

Vision Enhancement

- Vision enhancement involves using techniques and technologies to improve and augment vision.
- The goal is to enhance visual capabilities whether for individuals with impaired vision or those seeking advanced features beyond natural sight.
- This is includes corrective glasses or lenses for people with weaker eyesight in order for them to see things clearly.
- This also includes enabling blind people to be able to see the surrounding by roving them pictures of their surroundings.
- Color correction technology is also available which allows color blind people to see colors that they are not able to and newer colors that were muted before.

- Other examples include bionic eyes (artificial eye basically), smart contact lenses (they provide information of surrounding/have sensors etc), AR glasses, VR headsets, night vision glasses.

Advantages:

- It can improve the visions of those with limited or poor vision, which can provide them with a better quality of life.
- It can improve the vision of those who are color blind, allowing them to see a greater scope of colors, and color correct h issue they may have.
- It can help improve visibility in scenarios where visibility is limited.

Disadvantages:

- The technology involved is expensive to manufacture.
- The use of night and thermal vision devices is limited or illegal in some countries

Wearable Computing

- Wearable computing refers to the incorporation of computing and information technologies into items that can be worn on the body.
- These include devices such as smart watches, fitness trackers, and augmented reality glasses that are equipped with sensors and processors.
- They offer functional functions such as step counting, heath data tracking along with fashionable purposes such as color changing led shoes, wearable art, etc.
-

Advantages:

- It allows greater access to important statistics regarding our daily health. This can improve our ability to monitor our health
- Users an sync their fitness devices together and can encourage each other and set each other challenges, improving people's motivation to exercise.
- It can aid communication by allowing a user to see alerts for any tet messages or emails that they have received on their wearable device. Some can even be used to make

telephone calls, This removes the need for user to take their mobile out of the ocket or bag.

Disadvantages:

- Users can become obsessed with their health statistics, which can lead to damaging thoughts.
- There can be compatibility issues between devices, such as fitness trackers and mobile phones that may mean data can't be shared between them.
- The accuracy of some health trackers can be dubious, as they are designed to monitor the average person and not the bespoke health of each person.
- Some people are concerned about the security of their data that s gathered by their wearable device. It is also possible for companies to use the data that us collected for marketing purposes, which uses may not be aware of.

Impact of new and emerging technologies:

Individuals and their lifestyles:

Positive:

- **Enhanced Connectivity:** it has significantly improved communication and connectivity, allowing individuals to stay connected with friends. Family and colleagues across the globes
- **Access to information:** Enables access to a vast knowledge base through the internet contributing to continuous education and personal growth
- **Increased efficiency:** Automation, AI and collaborative tools have enhanced work efficiency, enabling individuals to be more productive and complete task more quickly and efficiently both in professional and personal domains
- **Health and well-being:** Wearable tech has contributed to personalized health monitoring, encouraging healthier lifestyles such as sleep trackers
- **Entertainment and leisure:** Streaming services, online gaming and VR provides with diverse exclusive entertaining experiences at their own convenience

Negative:

- **Privacy concerns:** Increased data collection and surveillance can lead to privacy infringements and potential misuse of personal information
- **digital addiction:** excessive use of technology, including smartphones and social media can contribute to addiction impacting mental health and overall well being.
- **Job displacement:** automation and artificial intelligence may lead to job displacement affecting employment opportunities for certain industries and roles
- **Security risks:** The rise of cyber threats including hacking and identity theft, poses risks to individuals' personal and financial security
- **Social isolation:** despite improved connectivity excessive reliance on digital communication can lead to reduced face to face interactions contributing to social isolation and diminished interpersonal skills

Organizations:

- **Increased efficiency:** IT and emerging technologies streamline operations automate tasks, and enhance overall efficiency within organizations leading to improved productivity.
- **Enhanced** communication: Advanced communication tools and platforms facilitate seamless collaboration among team members both within and across organizations fostering better connectivity.
- **Data insights:** Advanced communication tools and platforms facilitate seamless collaboration among team members, both within and across organizations fostering better connectivity
- **Global reach:** Digital technologies enable organization to reach a global audience, expanding market reach and facilitating international businesses operations
- **Innovation and agility:** IT fosters a culture of innovation, allowing organizations to adapt to changing market conditions, implement new ideas and stay competitive in dynamic industries

Negative

- **Security vulnerabitlities:** Increased eliance on digital systems exposes organisations to cybersecurity threats, including data breaches, ransomware attacks and other forms of cybercrime
- **Job displacement:** automation and advanced technologies may lead to job displacement, particularly in industries where routine tasks can be easily automated, causing workforce challenges

- **high implementation costs:** adopting and integrating new technologies can be expensive involving substantial upfront costs for hardware, software and training
- **Dependence on technology:** Overreliance on technology can create vulnerabilities as organizations may face significant disruptions in case of system, failures. Outages or technological dependencies
- **Privacy concerns:** The collection and use of extensive data for business purposes raise ethical concerns and can lead to legal and reputational issues if not managed responsibly

Development and Use of Prosthetics:

q6/33/mj/23 (6)

- CAD is used to design/analyze/optimize devices with greater precision/customization for individuals.
- CAM used to create multiple/iterative prototypes during developments so better customization
- 3D modeling used during design/development of devices resulting in quantity than hand-crafted devices fo testing/use
- 3D scanners used to measure/quantify areas for implanting/attaching prosthetics to body location/residual limb so fit better
- Use of electronic devices with computer/microprocessors-controlled feedback loops to enhance performance/better mobility/use
- Connections to nerve supplies via microprocessor systems to allow control/movement/feedback of devices by brain/nerve supply for better control
- Myo-electric prostheses capturing muscle electric signals through skin and used to control artificial/prosthetic device/fingers/hand/leg/foot for more precision
- Microprocessor systems used to interpret/analyse data from sensors in device for better control
- Microprocessor systems used to send signals to actuators in prosthetic/control actuators in prosthetic to mimic the natural movements more closely
- Sensors used synthetic nerve system to detect touch/read Braille/respond to environment changes.

Development and Use of Tissue Engineering:

Advantages: *q7/32/mj/20 (8)*

- Tissue engineering uses biological material/cells methods to replace/improve/alter biological structures/tissues with a greater success rate in patients.
- Tissue engineering uses biochemical techniques to replace/improve/alter/biological structures/tissues with a greater success rate in patients.
- Development/use of substitute materials for tissues has reduced costs/
- Reduces the need for biological donors e.g. use of artificial blood/skin.
- Reduces the recover times for patients.
- Reduces the risk of tissue rejection.
- Can produce customized tissues/organs/cells for individual patients.
- Development/use of artificial organs has increased survival/recovery rates e.g. use of artificial live/pancreas/cartilage/bone marrow.
- Religious objections to donated organs/tissue can be overcome using artificial tissues
- Production of artificial meat products reduces environmental impact of animal farming

Disadvantages:

- Can be very costly to carry out if sufficient base/original materials limited so new material must be developed
- May not be sufficient base/ original material available for development
- Possible inclusion of hidden diseases/conditions in base tissue
- Latent diseases are difficult to find with current technology
- Ethical issues are difficult to resolve
- Can increase the treatment time as tissue can take longer to grow/synthesize

Development and Use of Artificial Blood Vessels:

- **Precision engineering:** IT and emerging technologies contribute to precision engineering in the development of artificial blood vessels allowing for highly accurate design, fabrication and customization to match individual patient needs.
- **Simulation and modeling:** Advanced simulation tools and modeling techniques enable researchers to simulate the behavior and performance of artificial blood vessels in various conditions, facilitating efficient testing and optimization.

- **Biocompatibility and improvement:** Through the use of IT, researchers can analyze and enhance the biocompatibility of artificial blood vessels ensuring that these implants integrate seamlessly with the body reducing the risk of rejection and adverse reactions
- **Data driven research: Big data anal**ytics and machine learning applications can process vast amounts of medical data, aiding in the identification of patterns and insights crucial for the development and continuous improvement of artificial blood vessels.

- **Ethical Concerns:** The development of artificial blood vessels raises ethical questions, particularly in terms of potential misuse, unauthorized access to patient data, and the ethical implications of advanced biotechnologies.
- **Security Risks:** With the integration of IT into healthcare, there is an increased risk of cyber security threats. Unauthorized access to sensitive patient information or manipulation of medical data can compromise the safety and efficacy of artificial blood vessels.
- **Dependency on Technology:** Overreliance on IT and emerging technologies may lead to issues in case of system failures, glitches, or cyber attacks, affecting the proper functioning and reliability of artificial blood vessels.
- **Cost and Accessibility:** The high cost of implementing and maintaining advanced technologies may limit accessibility to artificial blood vessels, creating disparities in healthcare access and affordability for different populations.

Design of Medical Tools and Equipment

- **Precision and Customization:** IT and emerging technologies enable the precise design and customization of medical tools and equipment, tailoring solutions to meet specific patient needs and improving overall efficacy.
- **Advanced Imaging and Visualization:** Technologies like 3D imaging and virtual reality enhance the design process, allowing for more accurate visualization of medical tools and equipment, aiding in improved functionality and performance.
- **Remote Monitoring and Telehealth:** Integration of IT facilitates remote monitoring of medical devices and the development of telehealth solutions, expanding access to healthcare services and improving patient outcomes.
- **Innovative Materials and Manufacturing:** IT contributes to the exploration and implementation of innovative materials and manufacturing processes, leading to the development of lighter, more durable, and cost-effective medical tools and equipment.
- **Security Vulnerabilities:** The incorporation of IT and connectivity in medical tools raises concerns about cybersecurity, with potential risks of unauthorized access, data breaches, and the compromise of sensitive patient information.
- **Dependency on Technology:** Reliance on IT can lead to challenges when technical failures occur. Malfunctions, software glitches, or system outages may impede the functionality of medical tools, impacting patient care.

- **Cost and Accessibility:** The high costs associated with implementing advanced technologies in medical tool design may limit accessibility for certain healthcare facilities or contribute to increased healthcare expenses, potentially creating disparities in access.
- **Ethical and Privacy Issues:** The use of emerging technologies may raise ethical questions related to patient privacy, consent, and the responsible handling of health data, prompting concerns about how information is collected, stored, and shared.

Scientific Research:

- **Data Analysis and Processing:** Advanced IT tools and technologies enable efficient analysis and processing of large datasets, accelerating scientific research by uncovering patterns, trends, and correlations.
- **Collaborative Research:** Emerging technologies facilitate collaboration among researchers, allowing for real-time communication, data sharing, and collaborative platforms that enhance the speed and effectiveness of scientific projects.
- **Simulation and Modeling:** High-performance computing and simulation tools enable researchers to simulate complex phenomena and model intricate processes, aiding in the understanding of scientific concepts and experimentation.
- **Automation in Laboratories:** Automation technologies powered by IT streamline laboratory processes, enhancing precision, reducing errors, and increasing the throughput of experiments, ultimately expediting the research workflow.
- **Data Security Risks:** Increased reliance on IT introduces cybersecurity threats, with the potential for data breaches and unauthorized access to sensitive research data, jeopardizing the confidentiality and integrity of scientific findings.
- **Technological Dependence:** Overreliance on technology may result in challenges when technical failures occur. System malfunctions, software errors, or hardware issues could disrupt research processes and impede the reliability of results.
- **Digital Divide:** Unequal access to advanced technologies can create a digital divide, limiting the participation of researchers from less privileged regions or institutions and potentially contributing to disparities in scientific advancements.
- **Ethical Concerns:** The use of emerging technologies in scientific research raises ethical questions, including issues related to the responsible use of AI, privacy concerns, and potential unintended consequences that may impact the ethical conduct of research.

On Environment (E-Waste):

Q5/31/mj/22

Question	Answer	Marks
5	*Discuss: write about a topic in depth in a structured way.* **Eight** from: e.g.: E-waste includes all components of devices/CPUs/power supplies/chips/wires which have to be discarded/recycled somewhere E-waste produces/contains harmful chemicals/compounds/metals that can end up in the environment ... e.g. lead/cadmium/mercury/beryllium/brominated flame retardants/Polyvinyl chloride (PVC)/Perfluorooctanoic acid (PFOA) E-waste produces/contains (other) substances which can get into environment ...e.g. aluminium/copper/germanium/gold/lithium/nickel/silicon/tin/zinc Recycling of harmful substances can pose significant risk to health of workers involved in the recycling/disposal resulting in their sickness/early death CRTs from monitors release lead/barium/phosphor into environment if broken/dumped PCBs release glass/tin/lead/dioxins/beryllium/cadmium when de-soldered/stripped by burning Computer chips release heavy metals when burnt/stripped by acid baths which pose a health hazard Plastics are released when cables/wires are stripped to recover metals/dumped into land fill and seep into the water system Plastics are released when cases/keyboards are broken up to recover metals/dumped into landfill Emission of fumes/compounds when burned into environment can affect air quality and have detrimental effect on health Effect on water quality can affect humans/wildlife/plant life E-waste pollutants can get into human food chain and affect people all over the world Need to increase the recycling of complete electronic devices to reduce pollution Need to recycle components safely to avoid hazardous substances being released Updating to new systems can use less energy/total cost of ownership. *Must have at least two from each for full marks.* *Must be a proper discussion for full marks.* *Max 6 marks if bullets/list of points.*	**8**

On Environment (Recycling):

- **Efficient Sorting and Processing:** IT technologies contribute to the development of advanced sorting systems that enhance the efficiency of recycling processes, ensuring more accurate separation of materials and reducing contamination.
- **Data Analytics for Optimization:** The use of data analytics and machine learning enables recycling facilities to optimize their operations, predict equipment maintenance needs, and improve overall resource utilization.
- **Traceability and Transparency:** Emerging technologies, such as blockchain, provide opportunities for creating transparent and traceable supply chains in recycling. This can enhance accountability and support initiatives for sustainable practices.
- **Innovation in Recycling Technologies:** IT and emerging technologies foster innovation in recycling methods, leading to the development of new techniques, materials, and processes that improve the overall effectiveness of recycling efforts.
- **Electronic Waste:** The rapid advancement of IT leads to a higher turnover of electronic devices, contributing to the growing issue of electronic waste (e-waste), which poses challenges in recycling due to the complexity of handling electronic components.

- **Technological Obsolescence:** Rapid changes in technology can result in the quick obsolescence of certain devices, making it challenging to recycle them efficiently and leading to increased disposal issues.
- **Energy Consumption:** The production and operation of advanced technologies can require significant energy consumption, contributing to the overall environmental impact of the IT industry, despite its contributions to recycling.
- **Economic Barriers:** The cost of implementing and maintaining advanced recycling technologies can be high, creating economic barriers for smaller recycling facilities or communities with limited resources, potentially leading to disparities in recycling capabilities.

On Environment (Power Consumption):

- **Energy Efficiency:** IT and emerging technologies contribute to the development of energy-efficient devices, systems, and infrastructure, reducing overall power consumption in various sectors.
- **Smart Grids:** Advanced IT solutions enable the implementation of smart grids, optimizing the distribution and management of electricity, improving efficiency, and reducing energy wastage.
- **Remote Monitoring and Control:** IT facilitates remote monitoring and control of energy systems, allowing for real-time adjustments, predictive maintenance, and optimization to enhance energy efficiency.
- **Renewable Energy Integration:** Emerging technologies support the integration of renewable energy sources into existing power grids, allowing for efficient harnessing and distribution of clean energy, reducing reliance on traditional fossil fuels.
- **Increased Electronic Waste:** The rapid turnover of IT devices and emerging technologies contributes to electronic waste (e-waste), leading to environmental concerns and energy-intensive recycling processes.
- **Data Centers' Energy Consumption:** The proliferation of data centers, driven by the demand for cloud services, contributes to significant energy consumption, posing challenges in managing the environmental impact of these facilities.
- **Manufacturing and Disposal Energy:** The production and disposal of IT devices involve energy-intensive processes, including manufacturing and recycling, contributing to the overall energy footprint of these technologies.
- **Technological Obsolescence:** The rapid advancement of IT and emerging technologies can lead to the premature obsolescence of devices, encouraging frequent replacements and contributing to increased energy consumption associated with manufacturing and disposal.

On Environment (Manufacturing Processes):

- **Green Manufacturing Practices:** IT and emerging technologies enable the adoption of green manufacturing practices, incorporating sustainable materials, energy-efficient processes, and waste reduction measures to minimize environmental impact.
- **Resource Efficiency:** Advanced technologies contribute to resource-efficient manufacturing, optimizing the use of materials, reducing waste, and promoting recycling, thereby minimizing the environmental footprint of production processes.
- **Renewable Energy Integration:** IT facilitates the integration of renewable energy sources into manufacturing processes, reducing reliance on non-renewable energy and decreasing carbon emissions associated with energy consumption.
- **Remote Monitoring and Optimization:** Internet of Things (IoT) devices and sensors allow for remote monitoring and optimization of manufacturing processes, leading to more efficient use of resources, reduced energy consumption, and improved overall sustainability.
- **E-Waste Generation:** The rapid turnover of IT devices and emerging technologies contributes to the generation of electronic waste (e-waste), which poses environmental hazards due to the presence of hazardous materials and the challenges of recycling.
- **Resource Depletion:** The manufacturing processes for IT components often involve the extraction and use of valuable and non-renewable resources, contributing to resource depletion and environmental degradation.
- **Energy Consumption:** The production of IT and emerging technologies can be energy-intensive, contributing to increased carbon emissions and environmental impact, especially if the energy used comes from non-renewable sources.
- **Pollution and Chemical Use:** The manufacturing of IT components may involve the use of chemicals and materials that can lead to pollution if not properly managed, posing risks to ecosystems and human health.